

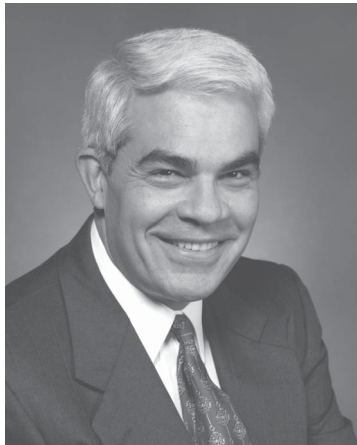
Institute for Manufacturing and Sustainment Technologies

IMAST

Q U A R T E R L Y

2002 No.3

A U.S. Navy Manufacturing
Technology Center of Excellence



Liszka Takes Helm of ARL

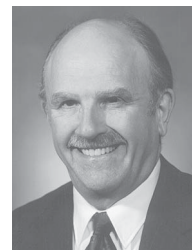
On 1 August 2002, Dr. Ed Liszka assumed the helm of Penn State University's Applied Research Laboratory (ARL), becoming its 8th director. Dr. Liszka succeeds Dr. Ray Hettche, who will remain at Penn State as a special advisor to the university, and ARL, until his planned retirement in 2003.

Dr. Liszka inherits a robust laboratory that has contributed markedly to the success of the U.S. Navy for over 57 years. A university center of excellence in naval science, with a preeminence in undersea missions and related areas, ARL Penn State provides solutions to challenges in national security, economic competitiveness, and quality of life. Discover, Develop, and Deploy remain its motto.

With degrees in electrical engineering and engineering acoustics from Penn State University, Dr. Liszka received his Ph.D. in applied physics (acoustics) from The Catholic University of America. From 1965 to 1982, he worked in Washington D.C. at Naval Sea Systems Command (NAVSEA) where he served as a program manager for undersea weapons guidance and control, and also underwater acoustics science and technology. He later served as head of the undersea warfare sensor and control branch.

From 1982 through 1984, Dr. Liszka was U.S. project officer for international data exchange on undersea weapons under the auspices of the Deputy Undersecretary of Defense for science and technology, international plans and programs. Concurrent with that assignment, he also served as technical director and deputy program manager for the advanced lightweight torpedo program at NAVSEA. During December of 1984, Dr. Liszka arrived at Penn State where he assumed a leadership role as associate director of ARL's undersea systems office. For the last year-and-a-half, Dr. Liszka served as Chief Scientist (Research and Technology) for the Chief of Naval Research, Officer of Naval Research in Washington, D.C.

The appointment of Dr. Liszka marks the end Dr. Ray Hettche's distinguished 21 year career as director of the Applied State. Under Dr. Hettche's leadership the in capabilities, external visibility, and Penn State will continue to provide the and the Department of Defense with support as the laboratory and Penn State Century. ARL will continue to promote through industry for economic This focus will support congressional and DoD mandates that technology from federally-funded research and development be put to dual-use by being transferred to the nation's commercial sector.



Research Lab at Penn laboratory has grown productivity. ARL Navy, Marine Corps, superior technical move into the 21st technology transfer competitiveness.

**Focus On
Manufacturing
Systems**

For more information about Penn State's Applied Research Laboratory and its role in supporting the U.S. Navy Manufacturing Technology (ManTech) Program, check our web site out at: <<http://www.arl.psu.edu/>>

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DIRECTOR'S CORNER

Changing of the Guard

Dr. Edward G. Liszka has assumed the role of Director of the Applied Research Laboratory (ARL), taking over from Dr. L. Raymond Hettche on August 1st, 2002. Dr.



Liszka served as the Chief Scientist at ONR. Prior to that tour of duty, he was the Associate Director for Undersea Systems at ARL.

This newsletter contains an article describing several of the funding vehicles for shipbuilding technologies. The efforts of the National Shipbuilding Research Program (NSRP) Advanced Shipbuilding Enterprise are highlighted. The Navy's Manufacturing Technology Program is conducted in concert with this effort. As well, both the Small Business Innovative Research Program and the Small Business Technology Transfer

Program have initiatives in the shipbuilding arena. The goal of these programs is to reduce the cost of building ships for the Navy. Given the enormous acquisition costs of ships, the potential savings are huge. Judicious investments can reap significant dividends. ARL is working on several projects supporting the shipbuilding affordability theme.

Now is the time to identify manufacturing issues for projects that will be starting in FY 04. I encourage program offices to discuss manufacturing challenges with the appropriate person listed under our masthead. You may also check our program web site for various program points of contact. My desire is to have the Navy and the Marine Corps identify the challenges and then, together with us, investigate if there is a technology mature enough to provide a solution in the timeframe required by the program office, within the constraints of available funding. Please do not hesitate to contact us if you have questions or issues.

Bob Cook



iMAST



**MATERIALS
PROCESSING
TECHNOLOGIES**



**MECHANICAL DRIVE
TRANSMISSION
TECHNOLOGIES**



**LASER
PROCESSING
TECHNOLOGIES**



**ADVANCED COMPOSITES
MATERIALS
TECHNOLOGIES**



**NAVY/MARINE
CORPS REPAIR
TECHNOLOGIES**



**MANUFACTURING
SYSTEMS
TECHNOLOGIES**

Focus on Manufacturing Systems

Shipbuilding Technologies at ARL Penn State

by Thomas M. Hite

Background on National Shipbuilding Research Program Advanced Shipbuilding Enterprise

The National Shipbuilding Research Program (NSRP) Advanced Shipbuilding Enterprise (ASE) is a collaboration of U.S. shipyards working with the Navy to reduce the cost of ship construction and repair by improving shipbuilding industry productivity through advanced technologies and manufacturing processes. The NSRP ASE is an innovative approach to public and private cooperation to manage cost-shared R&D, based on a national consensus Strategic Investment Plan (SIP). The SIP targets industry-wide technology challenges and calls for matching government and industry investments over several years. The collaboration's organizational structure provides incentives for industry, government, and academia to team in order to achieve continuous product and process improvements.

NSRP's ASE mission is to manage and focus national shipbuilding research and development funding on technologies that will reduce the cost of warships to the U.S. Navy. The NSRP ASE also provides a collaborative forum to improve business and acquisition processes.

A vision of the NSRP ASE is that by 2008, through collaborative development of product and process improvements, the U.S. shipbuilding industry will become a robust, self-sufficient industry that:

- Is recognized as able to build ships as efficiently and cost effectively as world competitive shipyards, and



has captured a significant increased share of commercial markets;

- Has significantly reduced the cost of ships to the Navy, has adjusted to the substantial reduction in military construction, and has preserved the infrastructure support Navy shipbuilding needs for the foreseeable future;
- Continues to be characterized by customer satisfaction, safety, quality, environmental compliance, and increasingly lean cost and cycle time.

The NSRP ASE investment portfolio includes six major initiatives as a tactical plan that ties the strategic vision to the proposed industry research through collaborative R&D and other mechanisms. The major initiatives constitute a high-level industry roadmap that calls attention to future technology needs, provides a structure for organizing technology forecasts, and communicates

to the industry, suppliers, academia, and government which technologies must be developed and implemented for future business success. The six major initiatives are:

- Shipyard Production Process Technologies
- Systems Technologies
- Business Process Technologies
- Product Design and Material Technologies
- Facilities and Tooling
- Crosscut Initiatives

Each major initiative is structured as a set of sub-initiatives that map the key areas of interest within a broad technology area and are used to project expected funding levels and time flow of investments over the multi-year program. Each one of the major initiatives is mapped into the Society of Naval Architects and Marine Engineers (SNAME) Ship Production Panels. These six major initiative panels, and three additional technology panels in the areas of welding, surface preparation and coatings, and environmental technologies, provide an open forum for technology transfer and best practice sharing among the U.S. shipbuilding industry and its stakeholders.¹

Support for NAVSEA SEA 05DP NSRP ASE Program Manager

ARL Penn State supports the NAVSEA NSRP ASE Program Manager, on both technical and programmatic issues. This support covers a wide range of tasks that include but are not limited to: technical review of project reports, attending various program and project review

PROFILE

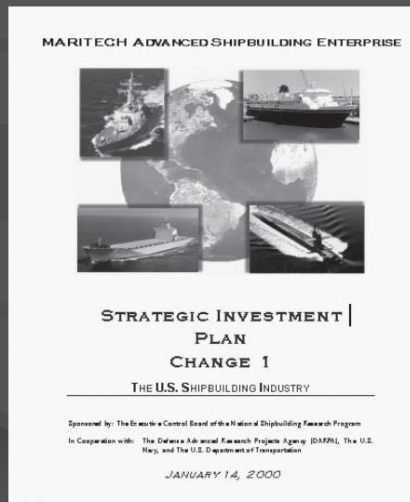


Tom Hite is an associate research engineer in the Materials and Manufacturing division at ARL Penn State. Joining ARL three years ago, Mr. Hite has put his 13 years of experience in ship design and program management to support the Naval Sea Systems Command's Ship Design Process Improvement Directorate (SEA 05DP) National Shipbuilding Research Program as well as the Office of Naval Research.

A graduate of the U.S. Merchant Marine Academy, with a B.S. degree in nautical science and marine transportation, Mr. Hite also holds an MBA from American University. He is currently pursuing a Ph.D. at Penn State's Smeal School of Business. Prior to joining Penn State, Mr. Hite was employed with Anteon Corporation in Rockville, MD and also Northrup Grumman's PRC, Inc. of McLean, VA. Mr. Hite can be reached at (814) 949-2665 or by e-mail at <tmh9@psu.edu>.

Strategic Investment Plan

- Investment Roadmap
- Problem statement
- Solution categories
- Funding needs
- General philosophy & background
- Executive Buy-In
- Broad participation
- Requirements Document
- Process Oriented to improve all products and programs



meetings, coordinating program booths at various national symposiums and expositions, reviewing budget issues, developing program/project presentations, writing program description papers, attending various program workshops, attending executive control board meetings, briefing high level NAVSEA, DOD, and Congressional personnel, and keeping accurate and up-to-date files on all of the above mentioned tasks. ARL Penn State provides the NSRP ASE program office representation on the welding technologies panel, environmental technologies panel, and the product design and materials technologies panel.

ARL Penn State acts as the liaison between the panel and the program manager on many issues that get raised at each meeting. ARL Penn State also represents the NSRP ASE Program Office at NAVSEA's Joint Industry Navy Industrial Initiatives (JINI) biannual meetings where ship repair/overhaul issues are discussed.

ARL Penn State has been involved as team members on three of the projects that have been awarded via the NSRP ASE. The first project was titled *Laser Assisted Forming of Steel*, in conjunction with Northrop Grumman's Ingalls Shipbuilding Division. Ingalls

subsequently decided to pursue this project under the Navy's DDX Program. Its funding was cancelled under the NSRP ASE.

A second project titled *Lean Enterprise Model* involved ARL Penn State teaming with Atlantic Marine, Inc.; Todd Pacific Shipyard; General Dynamics/Bath Iron Works; and Puget Sound Naval Shipyard. The principle objective of this project is to complete a comprehensive model for the application of lean manufacturing concepts to multiple market segments of the U.S. shipbuilding and repair industry. The enterprise-wide model will address lean design, materials and manufacturing practices. It is anticipated that this project will result in strategic improvement in overall shipyard cost and cycle time performance, including a 20% improvement in overall productivity within 3 years. The metrics used to measure this projects success will include a reduced number of quality deficiencies, reduced pre-construction labor costs, reduced pre-construction cycle time, reduced production labor cost, reduced production cycle time, and reduced material costs.²

The third project awarded was titled *USAShipbuilding.com*. Under this project, ARL Penn State provides the

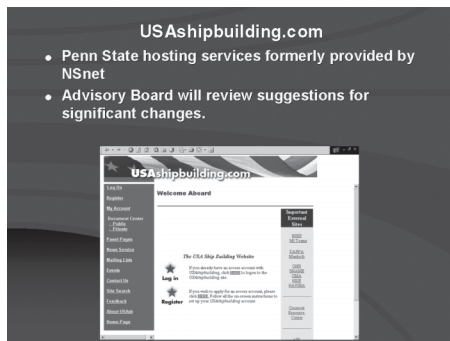
maritime industry with a central industry-specific electronic portal for information pertaining to the NSRP ASE program and related Navy/Maritime news and information. The content and services provided by this new homepage will benefit various segments of the shipbuilding industry including: commercial shipyards, naval shipyards, Navy program offices, shipping companies, marine service organizations, and academic partners. For the past five years, ARL Penn State has been at the forefront in the design, development, and implementation of new information technologies, including program-specific Internet-based systems for both private industry and defense-related organizations.

State-of-the-Art Reports

Each of the six NSRP ASE major initiative panels, as well as the three technology panels, developed state-of-the-art reports in each of their cognizant areas of expertise during fiscal years 2000 and 2001. The Office of Naval Research's Manufacturing Technologies Centers of Excellence (COE's) were asked to assist in writing these reports. ARL Penn State was assigned the primary source role for assisting the Systems Technology Panel and the Surface Preparation and Coatings Panel. ARL Penn State was assigned as a secondary source for the Ship Production Processes Panel, Welding Technologies Panel, Environmental Technologies Panel, and the Product Design and Materials Technologies Panel.

NSRP ASE Panel Projects

ARL Penn State is currently involved in one ongoing panel project. The work being done on this panel addresses a Crosscut Initiative on a project titled *Implementing a Virtual Resource Center*. This project will help address critical people and organizational needs by implementing an on-line resource center that can be used by industry professionals supporting Human Resources, Organizational Change, Training and Education, and Technology Transfer issues. The availability of resources in the center will reduce



redundancies in development of capabilities across shipyards. It will also allow industry professionals to maximize available resources. The historical project that ARL Penn State has already completed its tasking on was in support of the Environmental Technologies Panel for a project titled *A Shipyard Model for National Pollution Discharge Elimination Standards*. This project provided a tool for shipyard environmental engineering managers to use at their respective shipyards on a case-by-case basis.

Office of Naval Research Industrial and Corporate Programs Department

Because affordability and manufacturability are top priorities for the Navy and Marine Corps, ONR's integrated science and technology program interests include consideration of the manufacturing methods used to build naval warfighting systems. With affordable and quality naval combat technologies in mind, ONR's Industrial and Corporate Programs Department stimulates advantageous government-industry partnerships and promotes the development in manufacturing of innovative, cost-efficient, and cost-reducing processes. The Manufacturing Technology Division helps reduce the inherent risk in the transition of research and development to full-scale production through its specialized Centers of Excellence.³

The ONR Manufacturing Technology (ManTech) Center of Excellence (COE) for Advanced Marine Technologies is located at the University of New Orleans. It is known as the Gulf Coast Region Maritime Technology Center (GCRMTC). GCRMTC's mission is

to help the U.S. maritime industry become more competitive on an international scale through sponsored research. The thrust areas of this center address:

- Improve Design and Production Technologies for Shipbuilding
- Reduction of Material Costs
- Reduction of Total Ownership Costs
- Education and Training
- Improved Environmental Engineering and Management⁴

The GCRMTC solicits concept proposals twice a year from university sources and once each year from maritime industry sources. But funding is divided equally between the two groups. The concept proposals received are processed through an external peer review process. The results of the peer reviews along with GCRMTC's recommendations are presented to the Government/Industry Advisory Board (GIAB) for ranking. Based on the ranking, the Centers Executive Director recommends which concept proposals should be issued as Requests for Proposals (RFPs). The Government Program Manager (GPM) reviews and approves these proposals. To date, seventeen industry proposals have been funded. Sixty-eight internal university proposals have also been funded.⁵

Three other programs administered out of the Industrial and Corporate Programs Department that have shipbuilding/repair impacts are: the Shipbuilding Initiative (SI) program, the Small Business Innovative Research (SBIR) program, and the Small Business Technology Transfer (STTR) program.

The SI program is a cooperative effort between ONR and the NSRP ASE program. The goal of this program is to connect the shipbuilders' needs, as identified in the NSRP ASE Strategic Investment Plan (SIP), with the technical capabilities of Navy ManTech COE's. ONR funds these projects directly to the COEs and manages the contracts. Implementation by shipyard team members is a key feature of this program. Seven of these projects have been awarded to date—two each in FY00 and 01, and three in FY 02.

The SBIR program is designed to apply innovative ideas from small businesses to specific research and development needs of the Navy. ONR, in cooperation with the NSRP ASE, and drawing on the SIP, includes a specific research topic on Technology for Shipbuilding Affordability in their SBIR solicitations. ONR funds these proprietary projects directly and manages the contracts; therefore the requirements for sharing results are not the same as NSRP-funded projects. However, the results of these projects are intended to be commercialized by the small companies and are available for sale to the entire industry. Fifteen projects under the shipbuilding technologies topic have been awarded to date. Four were awarded in FY00, four in FY01, and seven in FY 02. The call for FY03 projects was just released on October 1, 2002.

The STTR program funds cooperative research and development between small companies and research institutions to address the needs of the Navy. ONR, in cooperation with the NSRP ASE and their SIP includes a specific research topic on Technology for Shipbuilding Affordability in their STTR solicitations. These projects were jointly funded by ONR and the NSRP ASE. They are proprietary; therefore the requirements for sharing results are not the same as NSRP ASE funded projects. However, the results of these projects are intended to be commercialized by the small companies, and are available for sale to the entire industry.⁶ Four projects under the shipbuilding technologies topic were awarded in FY00. ONR is planning for another STTR shipbuilding technologies topic solicitation in January of 2003.

Support for ONR Program Officer for Shipbuilding Technologies, Code 36 I

ARL Penn State supports the ONR Program Officer for Shipbuilding Technologies (Code 361), on both technical and programmatic issues. This support includes performing various tasks for the ONR Program Officer through his role as the Government

Program Manager for the GCRMTC. These efforts include internal and external proposal reviews, internal and external interim and final report reviews, attending quarterly program reviews, attending bi-annual Government/Industry Advisory Board (GIAB) meetings, attending the annual ONR Navy/Industry Partnership Symposium, attending the annual ONR Shipbuilding Technologies Symposium, tracking action items from these meetings, reviewing budget issues, developing program presentations, writing program description papers, attending various program workshops, helping with administrative functions with the SI, SBIR, and STTR projects, and keeping accurate files on all of these tasks.

Involvement with ONR's Shipbuilding Programs and Participation with GCRMTC

ARL Penn State serves as a voting member on the GCRMTC's GIAB. ARL Penn State personnel have performed work on an internal GCRMTC project titled *Simulation Based Design for Surface Ship Propulsors*. ARL Penn State has been awarded tasking on five ONR SI projects. The first is titled *Advanced Steel Fabrication Processes*. The goal of this project is to develop and deploy tools that will enable the U.S. shipyards to realize a world-class low volume/high value steel manufacturing process. This project is expected to reduce steel fabrication time by 10%. Qualitative benefits include improved corporate memory in the steel fabrication process; less reliance on an experienced, aging work force; reduced inspection time; and improved quality. The second project is titled *Flash-Rust Impact on Coatings*. The goal of this project is to transition the knowledge gained through test and evaluation into a Navy-approved flash-rust standard and measurement technique. This project is expected to have an 80% reduction on rework to restore blasted surfaces to white or near white metal surface conditions. The third

project is titled *Hybrid Welding of Ship Structures*. The goal of this project is to impact the design and fabrication of the Navy's CVX and DDX platforms by examining hybrid welding (laser and arc together) for use in the fabrication of ship structural components. The expected benefits of this project include reduced costs by eliminating scrap. Reducing post-weld processes, improved workflow, accuracy and performance will also reduce cost. The fourth project is titled *Cluster Based Manufacturing*. The goal of this project is to create a methodology to rapidly build, assess, and modify process models to support structural assembly product cells. The fifth project titled *Overspray Elimination through Development of High Transfer Efficiency Painting Technologies*. The goal of this project is to eliminate overspray through development, pilot scale application, and commercialization of high transfer efficiency paint application technologies.⁷

SBIR/STTR Programs

In the fall of 2000 ARL Penn State hosted an ONR SBIR workshop for Pennsylvania small businesses. As a result of this workshop, a small business from the State College, PA area was successful in being awarded a FY01 SBIR project under the Shipbuilding Technologies topic. The company, RLW Inc. was awarded a project titled *Integrated Conditioned-Based Maintenance (CBM) & Machine Control System*. The goal of this project is to demonstrate the commercial and technical merits and feasibilities of combined CBM and control systems for diesel generator sets on the Caterpillar 3608 and 3616. The direct near-term benefits will be cost savings in the acquisition and maintenance of the 3600 series generator sets. Recently, on October 1, 2002 ARL Penn State again hosted an ONR SBIR/STTR workshop. This meeting was attended by over seventy people representing more than fifty companies.

Addressing the Challenge

As the U.S. Navy moves forward to transform new processes into the fleet,

the NSRP ASE Program is needed more than ever. Sea Enterprise is dependent upon business efficiencies focused on process improvements that affect all ship programs—not just “program-only” or “stovepipe” perspectives. The NSRP ASE Program, managed by the shipbuilding industry, focuses on: (1) industrial and business process improvements on warship platforms, (2) improving shipbuilding and ship repair activity, and (3) rapidly implementing technology to place more capability in the hands of the warfighter. All these are at an affordable cost. The program boasts a 6-to-1 return on the U.S. Navy's investment. This is backed up with specific hard facts and examples on shipbuilding contracts where NSRP ASE projects have reduced the bottom line, or increased availability which provide warfighters with more capability. Research and development projects, which began in late 1999, address shipbuilding cost growth control. This cost control will not penalize current or future readiness. A close alignment with SECNAV transformational goals as well as CNO priorities were factored first into the equation.

Summary

NSRP's hallmark is rapid, widespread technology implementation for U.S. Navy shipbuilding and ship repair programs. Conscious across-the-board shipyard solicitation efforts have been initiated and implemented. These efforts will directly affect the industry's ability to produce the future ships and system platforms required for SEAPOW 21. Over 65% of NSRP ASE projects, to date, have already been implemented in at least one shipyard.

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4. Gulf Coast Region Maritime Technology Center Webpage, <www.gcrmtc.org>
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7. NSRP ASE Program Projects Book, Summer 2002, Advanced Technology Institute, Inc., June 2002.



Penn State's LAV-25 is shown at the test site with the IR signature-reducing shroud enveloping the muffler. Using a hand-held meter to measure LAV-25 noise levels, an ARL research engineer records noise levels at various rpms.

Mobile Electronic Warfare Support System (MEWSS) Noise Issues Addressed for Marine Corps

Past success addressing MEWSS PIP vehicle noise issues have resulted in tasking by the Marine Corps Systems Command to quantify noise signature relative to an Infra-Red (IR) signature-reducing muffler shroud replacement for the current design-of-record MEWSS PIP. The availability of an Generation II LAV-25, currently resident at ARL Penn State, has allowed testing to be conducted. Sound pressure spectra was measured at a number of angular orientations relative to the stationary vehicle with the baseline muffler and the IR signature-reducing shroud/muffler installed. The LAV's engine was operated over a range of speeds for the measurements at a designated test site on campus. Data acquired during the tests is currently being analyzed by ARL Penn State. Recommendations for noise control will be provided to the sponsor. For more information about this effort, contact Dr. Tim Brungart at (814) 863-3034 or by e-mail at tab@wt.arl.psu.edu.



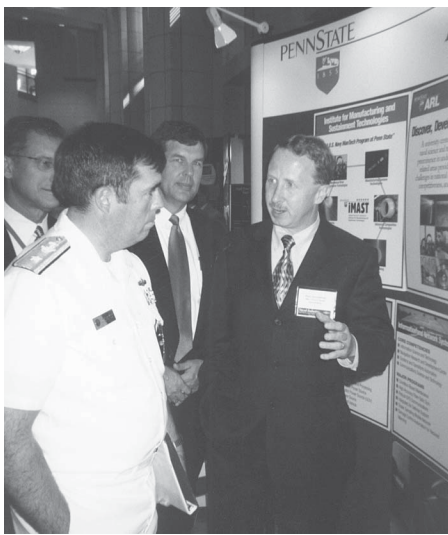
Dr. Ed Liszka (center), ARL Penn State's new director, discusses Navy ManTech program with Congressman John Murtha (right) while iMAST director, Mr. Bob Cook (left), looks on.

ARMTech Showcase

Members of iMAST recently participated in the annual Armstrong County Technology Showcase held in Kittanning, PA. Participation in events like this showcase is an essential part of the technology transition effort which Navy ManTech requires. As with any technology, the ability to transfer and implement technology depends on finding appropriate industry partners. Events like the Armstrong County (western Pennsylvania) Technology Showcase provide an opportunity for government, academia and industry to meet in order to identify and exchange new ideas for technological innovation. This, in turn, provides a vehicle which can embrace the production and performance of DoD-related products, at an affordable cost to the U.S. taxpayer.

ONR Naval-Industry R&D Conference

Amid the impressive interior of Ronald Reagan Building and International Trade Center in downtown Washington, D.C., iMAST participated in the third annual conference sponsored by the Office of Naval Research. Established to leverage dialog between government, industry, academia, and the U.S. Navy, a series of interactive breakout sessions provided forums to seriously discuss the challenges facing the defense industrial base. Next year's conference will be held again in Washington, D.C. at a date to be announced.



RAdm Charles Hamilton, PEO Surface Strike Warfare, discusses ARL capabilities with Dr. Tom Donnellan (right), associate director for materials and manufacturing at ARL Penn State, and Mr. Bob Cook (center), director of iMAST.

iMAST Attends DoD Maintenance Symposium

Members of iMAST recently attended the annual DoD Maintenance Symposium in Reno, Nevada. The focus, "Turning Logistics Resources into Readiness", provided an excellent forum for discussing the valuable role maintenance plays in the DoD's readiness posture. Maintenance is at the center of a set of six collaborative initiatives being developed by the Deputy Under Secretary of Defense for Logistics and Material Readiness. These initiatives are aimed at transforming logistics support on behalf of the warfighter as we move into 21st Century. Maintenance continues to play a significant role in the acquisition process. In view of iMAST's unique role in repair technology for both the Navy and the Marine Corps, it is imperative that we continue to participate in events like this in order to help advance the state of the art. Next year's symposium will be held October 27–30 at the Valley Forge Convention Center in King of Prussia, Pennsylvania. We will keep you updated. For more information on iMAST's role in maintenance and repair technology, contact Sean Krieger at (814) 863-0896 or at slk22@psu.edu.

CALENDAR OF EVENTS

13–14 Nov.	Materials and Manufacturing Advisory Board meeting		State College, PA
2–5 Dec.	Defense Manufacturing Conference 2002	★★★★★ visit the iMAST booth	Dallas, TX
2003			
16–17 Jan.	ShipTech 2003		Biloxi, MS
3–6 Mar.	DoD Logistics Conference		New Orleans, LA
TBD Mar.	Navy League Expo		Washington, D.C.
8–10 Apr.	TACOM/Industry Logistics Symposium		Troy, MI
TBD Apr.	Tech Trends 2003	★★★★★ visit the iMAST booth	TBA
5–6 May	Navy Opportunity Forum		Washington, D.C.
6–8 May	American Helicopter Society Forum	★★★★★ visit the iMAST booth	Phoenix, AZ
14–16 May	Coast Guard Innovation Expo		Baltimore, MD
9–12 Jun.	Intelligent Vehicle Technologies Systems Expo		Traverse City, MI
TBD Aug.	4th Annual ONR Naval-Industry R&D Conference	★★★★★ visit the iMAST booth	Washington, D.C.
16–18 Sep.	Marine Corps League Expo	★★★★★ visit the iMAST booth	Quantico, VA
TBD Oct.	AUSA Expo		Washington, D.C.
14–15 Oct.	NCEMT Friction Stir Welding Conference		Johnstown, PA
27–30 Oct.	DoD Maintenance Symposium 2003		King of Prussia, PA

Quotable

“The most advanced aircraft, ship or weapons system is of no value without highly motivated and well-trained people.”

—General James Jones, U.S. Marine Corps

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